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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of Giant CCN on warm rain processes in the ECHAM5 GCM" *by* R. Posselt and U. Lohmann

Anonymous Referee #2

Received and published: 29 January 2008

This paper is concerned with the effect of giant CCN particles (sea salt) on clouds and precipitation in a global climate model. It is important work. As far as this reviewer is aware, this is the first study to investigate the influence of GCCN.

There are a few issues, however. It seems (p14776, Section 2.3) that the ECHAM5-GCCN10/5 model runs are essentially ECHAM5-RAIN with GCCN (r>10 um and 5 um) included. The ECHAM-RAIN model is the subject of a paper currently under review (Posselt and Lohmann). The reviewers of that paper (Interactive comments) suggest that there are problems with the approach.

Furthermore, while it is appreciated that investigation of the influence of GCCN on warm rain production is a major step forward for GCMs, the influence of the GCCN

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(and CCN) on the initiation of ice and development of precipitation via the ice phase cannot be ignored. There should at least be discussion of this issue.

This reviewer therefore recommends that the current paper be rejected at this stage.

Some specific comments follow. Note, comments about some details of the results are not given because of the issue concerning the Posselt and Lohmann paper stated above.

1. p14768, Abstract: It is unusual to see as much detail in the abstract. It reads more like an introduction in places, but without the references to support statements made. For example, "Sea salt concentrations..."

2. p14769, Introduction: Statements should be backed up with references.

3. p14769, Section 1.1: Ref for first sentence. In mass or number?

4. p14770, l15: Woodcock's paper should be referenced.

5. p14772-3: Any paragraph discussing the seeding of clouds with hygroscopic nuclei should mention the excellent paper by Cooper at al, 1997, JAM. The paragraph is confusing. What is meant by the sentence, "Small aerosol particles.... do not become re-activated."? It is implied in the paragraph that this may be because the supersaturation is lowered by the activation of the GCCN. Where does the evaporation occur? Evaporation due to entrainment and mixing higher in the cloud will likely cause an increase in supersaturation and consequently an increase in the concentration of small cloud drops. What is meant by broadening the drop spectra and what is the evidence that it is a help in initiating rain?

6. p14773, last pgph: The paragraph does not give details of the layout of the paper in the traditional way. It's not often necessary, but it would be helpful in this case since there are so many model options.

7. p14775: The results clearly depend critically on the GCCN-rain parameterization. It

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is good to see the sensitivity studies in Section 3.1. There is no connection between these two sections, however. There is no mention of the sensitivity studies on the radius of the rain drops for example.

8. p14775: The point of Fig. 1 is not clear. Observations of warm, shallow cumulus clouds show that the radar reflectivity typically increases from almost 0 dBZ to 40 dBZ within 15 minutes. So condensation alone for this length of time does not represent what is going on.

9. p14777, l18-19: In some cases the incorporation of GCCN does seem to compensate for the increase in concentration of CCN. This should be stated.

10. p14777, l19-24 and elsewhere: Has the result of too much transfer of cloud water to rain water been observed? There is a lot of attention given to this result in the paper. If so, please give a reference. If not, surely including this extreme is misleading. Also, entrainment and mixing is likely to deplete the available cloud water before the initiation of precipitation does, yet there is no mention of an entrainment scheme in the paper.

11. p14777, l24-25 and elsewhere: Does this statement refer to within a model time step? How do you get large raindrops ($d > 2$ mm) that are frequently observed in real clouds? The issue should be clarified.

12. Fig. 4 caption and text: State what the difference is between.

13. Section 3.2.1: The section is too long. There seems to be repetition of material presented in Posselt and Lohmann (2007).

14. p14781-14782, Fig. 7: It is good to see these distributions since the warm rain process depends so much on them. The figure (and Fig. 8) should appear earlier in the paper in Section 2. The simulated distributions do indeed underestimate the observed distributions for all wind speeds. Presumably this suggests improvements to the scheme. If it is possible, the effect of these errors on the precipitation should be shown.

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15. Fig 9: This figure is too small.

16. p14783, l17: It is stated later that there are "major" changes.

17. p14784, pgph 1: This paragraph could be a paper in itself. Firstly, here is confirmation that deep convection is included with no consideration of the influence of GCCN on the production of precipitation via ice. Secondly, please provide references and provide more detail for the statements about the triggering of convection in ECHAM5 and less convection downwind of precipitation.

18. p14784, pgph 2: See comments above about transfer of water. The extreme situation perhaps should not be included.

19. p14783, l24-25: Is it certain that there are no GCCN over the continents? Reference?

20. p14785 - 14786: Is Fig 11 correct? It is difficult to understand the discussion of this figure.

21. p14786, l10-12: Fig 8a suggests that the observed concentration of GCCN is slightly larger than the modeled concentration. This sentence therefore suggests that there is a model problem. See related comment above.

22. p14786, l19-22: Please explain in detail what this statement means!

23. p14788-14789: References for increase in wind speed and for decrease in GCCN ratio.

24. p14790, l25-end: Again, please clarify and note comment on influence of GCCN on mixed-phase precipitation.

Editorial issues:

1. The paper is well written, but there are a few places where the grammar should be checked.

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2. p14769. Define u10.

3. The word "thereby" is frequently used incorrectly.

4. Fig. 4: The key for the radius of activated raindrops is incorrect.

5. p14778, l8: Fig 4.

6. p14778, l17: Suggest changing "lower cloud cover" to "less...".

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 14767, 2007.

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